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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/671,143
Filing Date: September 25, 2003
Appellant(s): LEE ET AL.

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Patrick S. Yoder
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed July 9, 2007 appealing from the Office action mailed July 24, 2006.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6,339,281	LEE et al.	01-2002
2004/0067602	JIN	04-2004
RE38561	KEESMAN et al.	08-2004
5,620,350	TAKEMURA	04-1997
5,451,830	HUANG	09-1995

6,815,877 CHEN 11-2004

Zhang et al. "Electric Field Directed Growth of Aligned Single Walled Carbon Nanotubes", Applied Physics Letters, Vol. 79, No. 19, November 5, 2001, pg. 3155-3157.

Bower et al. "Plasma induced alignment of carbon nanotubes", Applied Physics Letters, Vol. 77, No. 6, August 2000, pg. 830-832.

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 1-6, 9, 13-19, 22-27, 29, 31-38, 42-48, 51, 52, 54-56, 99 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. (U.S. Pat. 6,339,281) in view of Jin (US PGPUB 2004/0067602).

Regarding claims 1, 32, 99, Lee et al. teach a method for fabricating a triode carbon nanotube field emitter array. (See Abstract) The method comprises providing a substrate 1 of glass with a cathode electrode 2. (Column 4 lines 1-3) A dielectric material is deposited on the surface of the substrate. (Column 4 lines 4-7) Depositing a conductor layer in the form of a gate electrode on the surface of the dielectric layer. (Column 4 lines 7-10) Gate openings 5 are formed by etching at selective locations. (Column 4 lines 10-13; Fig. 2C) The dielectric layer is electively etched in the locations of the openings 5 to form a micro-cavities 6. (Column 4 lines 14-16) In Fig. 4A a base layer structure is deposited in the micro-cavity adjacent the surface of the substrate and the base layer in the microcavity has a substantial concial shape. (Column 5 lines 5-10; Fig. 4A) A catalyst layer is deposited on the base layer structure suitable for growing at

least one carbon nanotube. (Column 5 lines 17-20) Carbon nanotubes are grown on the catalyst layer as self-aligned. (Column 5 lines 27-34; Fig. 4D)

Regarding claims 2, 33, the substrate is deposited metal on glass. (Column 4 lines 2-3)

Regarding claims 3, 34, the dielectric material is oxide or nitride. (Column 4 line 5)

Regarding claims 4, 35, the oxide can be silicon dioxide. (Column 4 line 5)

Regarding claims 5, 36, the nitride can be silicon nitride with a nitrogen content of 1.33. (Column 4 line 5)

Regarding claims 6, 37 the gate electrode by its nature is conducting and conducting materials cover metals or semiconductors. (Column 4 lines 4-9)

Regarding claims 9, 38, a separation layer 7 is deposited on the conductor layer electrode. (Column 4 lines 25-27) Here the separation layer 7 is interpreted to be the sacrificial layer.

Regarding claims 13, 42, a base layer 8 and 8' is deposited on the sacrificial layer and a portion of the substrate. (Column 5 lines 5-10)

Regarding claims 14, 43, the base layer can comprise metal such as Au, Pt or Nb. (Column 5 lines 5-10)

Regarding claims 15, 44, the base layer can comprise metal such as Au, Pt or Nb. (Column 5 lines 5-10)

Regarding claims 16, 45, a catalyst material is deposited on the surface of the base layer. (Column 5 lines 17-21)

Regarding claims 17, 46, the sacrificial layer is removed along with the corresponding base layer and corresponding catalyst layer. (Column 5 lines 28-32)

Regarding claims 18, 47, the catalyst comprises at least one transition metal. (Column 5 lines 17-20)

Regarding claims 19, 48, the catalyst comprises Ni or Co. (Column 5 lines 17-20)

Regarding claims 25, 54, at least one carbon nanotube is grown by chemical vapor deposition. (Column 5 lines 27-28)

Regarding claim 31, the structure is a self-aligned triode carbon nanotube field emitter array. (See Abstract)

The differences between Lee et al. and the present claims is that utilizing an electrical potential to cause a field to form at the substrate such that the carbon nanotubes grow in a direction perpendicular to the surface of the substrate is not discussed (Claims 1, 32, 99), the length of the carbon nanotube is not discussed (Claims 22, 23, 51, 52), the carbon nanotube being single walled double walled or multi-walled is not discussed (Claims 24), the use of a flowing carbon source is not discussed (Claims 26, 55) the carbon source being methane is not discussed (Claims 27, 56) and the carbon tube being a metallic carbon nanotube is not discussed (Claim 29).

Regarding utilizing an electrical potential to cause a field to form at the substrate such that the carbon nanotubes grow in a direction perpendicular to the surface of the substrate (Claims 1, 32, 99), Jin teach growing nanowires form catalyst by CVD utilizing a globally applied field along the vertical direction (perpendicular to the substrate) or by

an intrinsically present electrical field perpendicular to the substrate to produce vertically grown nanowires. (Page 3 paragraph 0050; Page 1 paragraph 0014)

Regarding the length of the carbon nanotube (Claims 22, 23, 51, 52), Jin teach that the length of the nanotube can be 1-500 nm. (Page 4 paragraph 0062)

Regarding the carbon nanotube being single walled, double walled or multi-walled (Claim 24), Jin suggest that the nanotubes can be multiwalled. (Page 1 paragraph 0014)

Regarding the use of a flowing carbon source (Claims 26, 55), Jin suggest utilizing methane to produce the nanotubes. (Page 1 paragraph 0014)

Regarding the use of methane (Claims 27, 56), Jin suggest utilizing methane to produce the nanotubes. (Page 1 paragraph 0014)

Regarding the carbon tube being a metallic carbon nanotube (Claim 29), Jin teach that the CVD gas can be mixed with Fe in order to produce a metallic type carbon nanotube. (Page 1 0014).

The motivation for utilizing the methods of Jin is that it produces aligned carbon nanotubes. (See Page 3 paragraph 0050)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Lee et al. as taught by Jin because it allows for growth of carbon nanotubes.

Claims 7, 10-12 and 39-41 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. in view of Jin as applied to claims 1-6, 9, 13-19, 22-27, 29,

31-38, 42-48, 51, 52, 54-56, 99 above, and further in view of Keesmann et al. (RE38,561).

The differences not yet discussed is that the conductor layer being metal (Claims 7), the material of the sacrificial layer (Claims 10, 39), depositing the sacrificial layer at an angle (Claims 11, 40) and rotating while depositing the sacrificial layer is not discussed (Claims 12, 41).

Regarding the conductor layer being metal, Keesman et al. teach forming the gate electrode of molybdenum. (Column 5 lines 37-39)

The motivation for utilizing Mo as a conductor is that it allows formation of a gate electrode. (Column 5 lines 37-39)

Regarding the material of the sacrificial layer (Claims 10, 39), Keesman et al. teach that the material of the sacrificial layer can be aluminum. (Column 5 lines 45-53)

Regarding depositing the sacrificial layer at an angle (Claims 11, 40), Keesman et al. teach depositing the sacrificial layer at an angle. (Column 5 lines 45-53)

Regarding rotating while depositing the sacrificial layer (Claims 12, 41), Keesman et al. teach rotating while depositing. (Column 5 lines 45-53)

The motivation for depositing a particular sacrificial material while rotating and depositing at an angle is that it allows for preventing closing of the cavity. (Column 5 lines 45-53)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized Mo and to have deposited a particular

sacrificial material while rotating and depositing at an angle as taught by Keesman et al. because it allows for formation of gate electrode and for preventing closing of the cavity.

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. in view of Jin as applied to claims 1-6, 9, 13-19, 22-27, 29, 31-38, 42-48, 51, 52, 54-56, 99 above, and further in view of Takemura (U.S. Pat. 5,620,350).

The differences not yet discussed is that the semiconductor material being doped poly silicon is not discussed (Claim 8)

Regarding the semiconductor being doped poly silicon (Claim 8), Takemura teach that the gate electrode can be made of doped poly silicon by CVD. (Column 4 lines 5-11)

The motivation for utilizing doped polysilicon is that it always formation of a gate electrode. (Column 4 lines 5-11)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized doped polysilicon as taught by Takemura because it allows formation of a gate electrode.

Claims 20, 21, 49 and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. in view of Jin as applied to claims 1-6, 9, 13-19, 22-27, 29, 31-38, 42-48, 51, 52, 54-56, 99 above, and further in view of Zhang et al. "Electric field directed growth of aligned single walled carbon nanotubes", Applied Physics Letters, Volume 79, Number 19, November 5, 2001, pg. 3155-3157.

The differences not yet discussed is the electrical potential applied to the substrate and the conductor layer (Claims 20, 49) and the electrical field induced (Claims 21, 50)

Regarding the electrical potential applied to the substrate and the conductor layer (Claims 20, 49), Zhang et al. teach utilizing a bias voltage of 5 V to cause alignment of carbon nanotubes. (See Page 3155)

Regarding the electrical field induced (Claims 21, 50), Zhang et al. teach a 1300 V/cm field for producing the nanotubes. (See Fig. 2 b)

The motivation for controlling the electrical potential and induced electric field is that it allows for producing aligned carbon nanotubes. (See Page 3155)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized a potential applied to the substrate and induced electric field as taught by Zhang et al. because it allows for producing aligned carbon nanotubes.

Claims 28 and 57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. in view of Jin as applied to claims 1-6, 9, 13-19, 22-27, 29, 31-38, 42-48, 51, 52, 54-56, 99 above, and further in view of Bower et al. "Plasma-induced alignment of carbon nanotubes", Applied Physics Letters, Volume 77, Number 6, August 2000, pg. 830-832.

The differences not yet discussed is the temperature for deposition (Claims 28, 57)

Regarding the temperature for deposition (Claims 28, 57), Bower et al. teach that the temperature for CVD can be 825 degrees C. (See Page 830).

The motivation for utilizing a temperature of 825 degrees C is that it allows deposition of carbon nanotubes. (See Page 830)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized 825 degrees C for depositing as taught by Bower et al. because it allows for deposition of carbon nanotubes.

Claims 30 and 53 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. in view of Jin as applied to claims 1-6, 9, 13-19, 22-27, 29, 31-38, 42-48, 51, 52, 54-56, 99 above, and further in view of Huang (U.S. Pat. 5,451,830) and Chen (U.S. Pat. 6,815,877).

The differences not yet discussed is utilizing chemical vapor deposition for the layers (Claims 30, 53)

Regarding deposition the layers be chemical vapor deposition (Claims 30, 53), Huang teach that the dielectric material and the conductor layer can be deposited by chemical vapor deposition. (Huang Column 3 lines 62-68; Column 4 lines 1-4) Chen teach depositing a base layer 401 for carbon nanotubes 402 by CVD. (Chen Column 3 lines 59-65) Lee et al. teach depositing the catalyst layer and the carbon nanotube layer by CVD. (See Lee et al. Column 4 lines 30-33; Column 5 lines 27-28)

The motivation for utilizing CVD to deposit the layers is that it allows for formation of emitter devices. (See Abstracts of Huang, Chen and Lee et al.)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized CVD for depositing the layers as taught by Huang, Chen and Lee et al. because it allows for formation of emitter devices.

(10) Response to Argument

Response to the arguments of Ground of Rejection No. 1:

In response to applicant's argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

In response to the argument that the prior art does not teach applying an electrical potential to the substrate and the conductor layer, it is argued that Applicant's claims require "applying an electrical potential to the substrate and the conductor layer" and that Jin teach applying an electrical potential to the substrate and the conductor in an electrical field that is either global or intrinsically present. The claims do not recite that that electrical field is "between" the substrate and the conductive layer. However, the electrical field would run between the substrate and the conductor layer due to the shape of the electrical field. (See Jin discussed above)

In response to the argument that Lee and Jin et al. fail to teach the creation of an in-situ electrical field, it is argued that the global or intrinsic electrical field is considered to be in situ since the electrical field exists in the location where the carbon nanotubes are being deposited. Furthermore, the claims do not require an "in situ" field. (See Jin et al. discussed above)

In response to the argument that applying an electrical potential to the substrate and the conductor is not equivalent to globally applying an electric field to the chamber where the fabrication of the nanotube is taking plate, it is argued that applying a global electric field will apply an electric potential to the substrate and the conductor. The presence of the filed applied the electrical potential. (See Jin et al. discussed above)

In response to the argument that claims 2-31 and 33-57 are patentable because they depend directly or indirectly form allowable independent claims, it is argued that claims 2-31 and 33-57 are not allowable for the reasons that the independent claims are not allowable as discussed above.

Response to the arguments of the Ground of Rejection No. 2:

In response to the argument that the secondary references do not obviate the deficiencies of Lee and Jin, it is argued that the combination of Lee and Jin provide the limitations of the claims including providing an electric potential to the substrate and the conductor in order to form nanotubes. (See Lee and Jin discussed above)

Response to the arguments of the Ground of Rejection No. 3:

In response to the argument that the secondary references do not obviate the deficiencies of Lee and Jin, it is argued that the combination of Lee and Jin provide the

limitations of the claims including providing an electric potential to the substrate and the conductor in order to form nanotubes. (See Lee and Jin discussed above)

Response to the arguments of the Ground of Rejection No. 4:

In response to the argument that the secondary references do not obviate the deficiencies of Lee and Jin, it is argued that the combination of Lee and Jin provide the limitations of the claims including providing an electric potential to the substrate and the conductor in order to form nanotubes. (See Lee and Jin discussed above)

Response to the arguments of the Ground of Rejection No. 5:

In response to the argument that the secondary references do not obviate the deficiencies of Lee and Jin, it is argued that the combination of Lee and Jin provide the limitations of the claims including providing an electric potential to the substrate and the conductor in order to form nanotubes. (See Lee and Jin discussed above)

Response to the arguments of the Ground of Rejection No. 6:

In response to the argument that the secondary references do not obviate the deficiencies of Lee and Jin, it is argued that the combination of Lee and Jin provide the limitations of the claims including providing an electric potential to the substrate and the conductor in order to form nanotubes. (See Lee and Jin discussed above)

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Rodney McDonald

Conferees:

NN

KG

Kathryn Gorgos